LA-UR -77-2686

MASTER

TITLE: WASTE MANAGEMENT CAPABILITIES FOR ALPHA BEARING WASTES AT THE LOS ALAMOS SCIENTIFIC LABORATORY

Conf-771208--3

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SUBMITTED TO: NEA/IAEA Technical Seminar on the Treatment, Conditioning, and Storage of Solid Alpha-Bearing Wastes and Cladding Hulls, Paris, France, December 5-8, 1977

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Form No. 836
St. No. 2629
1/75

UNITED STATES
ENERGY RESEARCH AND
DEVELOPMENT ADMINISTRATION
CONTRACT W-7405-ENG. 36

WASTE MANAGEMENT CAPABILITIES FOR ALPHA BEARING WASTES AT THE LOS ALAMOS SCIENTIFIC LABORATORY

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Abstract

Waste Management activities at the Los Alamos Scientific Laboratory (LASL) involve a broad range of effort. There are requirements for daily processing of both liquid and solid radioactive and chemical wastes using a variety of technical operations. Approximately 4.5×10^7 ℓ/yr of liquids and 9×10^3 m^3/yr of solids are processed by the Waste Management Group of the LASL. In addition, a vigorous program of research, development, and demonstration studies leading to improved methods of waste treatment is also carried out within the same group. The current developmental studies involve incineration of transuranic-contaminated combustible wastes as well as other waste management aspects of alpha emitting transuranic (TRU) isotopes.

Introduction

The Los Alamos Scientific Laboratory (LASL) is located in the southwestern region of the United States in the State of New Mexico. Since World War II, the LASL has been the primary research and development laboratory for the United States Atomic Energy Commission (AEC) (1946-1974); then the United States Energy Research and Development Administration (ERDA) (1975-1977); and since October 1, 1977, the United States Department of Energy (DOE). Although the initial (late 1940's) emphasis of the Laboratory was on nuclear weapons, the scope and direction have broadened through the years to include other energy interests of the United States (nuclear, fusion, solar, geothermal, etc.) along with fundamental physics, metallurgy, and chemistry research which the Laboratory is uniquely equipped to carry out.

All such studies generate waste and it is the responsibility of the LASL Waste Management Group to treat and process these wastes. The nature of the Laboratory's work does not result in the generation of so-called high-level wastes and only a small (<10 m^3/yr) amount of intermediate-level wastes. Therefore, the bulk of the LASL efforts deal with waste resulting from low-level transuranic (TRU) elements. The LASL is self-contained regarding wastes; none are sent to other facilities and no wastes from outside agencies are transferred into the Laboratory.

Liquid Waste Treatment

The Waste Management Group processes approximately 4.5 x 10^7 ℓ/yr of low-level liquid wastes containing approximately 1.4 x 10^{-4} μCi/mℓ of TRU. This liquid stream originates at several Laboratory facilities and is treated at two separate plants in conventional commercially available clariflocculation equipment. The activity is removed by controlled precipitation of ferric hydroxide followed by ion-exchange where necessary. Settling tanks and filtration are also used. An elaborate piping system allows wastes to be recycled if required before the depleted supernatant is discharged to a dry canyon. Table I shows the LASL liquid waste processing data for 1976. The sludge or precipitate containing the radioactivity is dried and placed in 200-liter fiber drums for burial if the residual activity is <10 nCi/g. Sludges containing more than this level are packaged in steel drums with a polyethylene liner for retrievable storage. Certain sludges containing moderate amounts of ^{241}Am are stored retrievably in 2300-liter metal pipe. The current United States guidelines for release of liquids containing TRU elements is 5 x 10^{-5} mCi/ℓ. The LASL does not discharge any liquid containing more than 50% of this amount; if necessary, the supernatant is recycled through the plant a second time. Figure 1 is a photograph of one of the clariflocculator units.

Solid Waste Treatment

Solid wastes are segregated and packaged at the generation point. Those solids containing >10 nCi/g are packaged in polyethylene-lined steel drums or fiberglassed plywood crates for retrievable storage; those solids containing <10 nCi/g are packaged in fiber crates or barrels for transport to the burial area.

With larger, more bulky items, known to be less than 10 nCi/g the item itself is buried. Figure 2 shows an example of such items awaiting burial.

All low activity trash type wastes (<10 nCi/TRU/g, <200 mR/hr surface) are compacted and baled in a 100,000 lb press prior to burial. Volume reduction values of 5:1 have been achieved with this device. A major project beginning in 1978 will be the decontamination of the old LASL plutonium processing facility. All gloveboxes

(≈600 linear meters), process equipment, ductwork, piping, etc., requires removal and storage or burial as required by contamination levels. These bulky TRU wastes will be reduced in volume by cutting under remote conditions with a plasma torch and will be packaged into fiberglassed crates for storage.

Both burial and storage operations at the LASL are carried out in excavated pits. The primary geologic structure underlying the Los Alamos area is made up of tuff which is compacted volcanic ash laid down approximately 10^6 years ago. The tuff is extremely dry with approximately 0.5% moisture content. Rainfall in the area is low at 25 cm/yr. The tuff is easy to excavate with conventional equipment; note from Fig. 2 that the walls of the burial pits are almost vertical. In addition, the LASL burial or storage pits are approximately 425 meters above the nearest aquifer or available water. Therefore, the climate and terrain at the LASL is almost ideal for shallow land burial or storage of wastes with sufficient space for the Laboratory's needs for the foreseeable future. Figure 3 shows an array of barrels of waste in a burial pit while Fig. 4 shows some of the earthmoving equipment backfilling the pit with the excavated tuff. Table II lists the amounts of material buried or stored during 1976.

The LASL has developed an electronic interrogation device called MEGAS (Multiple Energy Gamma Assay System) which will allow fiber boxes containing low-density wastes (wiping rags, clothing, shoe covers, etc.) to be scanned and discriminated at the 10 nCi/g level of TRU. Figure 5 shows the device in operation with a waste box rotating in front of a NaI detector. Using this device, more than 90% of the waste boxes from a plutonium processing area have been shown to have <10 nCi/g and can be sent to the more inexpensive burial mode rather than retrievable storage. An elaborate record system is maintained of all containers and their location in the burial pits or storage areas.

The activities described above are concerned primarily with the necessary daily processing or treatment of the wastes generated throughout the Laboratory. In addition to this work, the LASL Waste Management Group carries out various programs for the United States Department of Energy involving development and demonstration of new or improved methods of waste characterization or processing to achieve volume reduction.

The specific volume reduction method now under investigation is incineration of combustible TRU contaminated wastes. Some years ago, as a result of a detailed engineering study, it was concluded that a controlled-air incinerator offered high promise of success for achieving both volume reduction and rendering the waste chemically inert. Controlled-air incinerators have been available in the United States and their satisfactory operation with nonradioactive combustible materials was an established fact.

The principle of controlled-air incineration involves two burning chambers; the first operating at 800°C under minimum or substoichiometric air to minimize particulate formation followed by a second combustion chamber operating at 1100°C with excess air to complete the combustion of the gaseous components generated in the first chamber.

Such an incinerator was purchased, installed, and tested with more than 1500 kg of synthetic combustible wastes but having the same ratios of paper, plastic, cloth, and rubber as might be expected from a radioactive processing area. Figure 6 shows the incinerator installed under these conditions. At this point and during the tests, there was no attempt to scrub or cleanse the off-gas and all particulate emissions were within the strict limits set up by the United States Environmental Protection Agency. Halogenated or sulfur-bearing materials were not burned during these tests.

In July 1976, the incinerator was moved to a new building and modifications were begun to allow operation with TRU contaminated wastes. This building, called the LASL Treatment Development Facility (TDF) is shown in Fig. 7. An elaborate off-gas scrubbing system was designed and coupled to the incinerator in addition to a suitable glovebox train for introduction of fresh waste. A MEGAS scanning system was installed in the train to allow monitoring of the incoming levels of TRU along with an X-ray scanner (similiar to those used in airports) for detection of noncombustible objects. Should a noncombustible be detected, the waste package would be opened, the item removed and separately taken from the glove box line.

A very elaborate instrumentation array was added to both the incinerator and the off-gas system to allow the acquisition of adequate data during the trial period. Figure 8 shows a schematic of the incinerator as modified for radioactive service.

The hot off-gases are first sent through a quench column in which they are contacted by a high-energy aqueous scrub. This scrub can be made basic if necessary to neutralize any acidic materials (HCl, for example, from burning polyvinyl chloride plastics). The gases then pass first through a venturi scrubber and then through a packed column to reduce their velocity and temperature. A condenser and reheater are next in line, the condenser to remove the last traces of moisture and the reheater to raise the temperature above the dew point before ultimate contact with a HEPA filter bank. All of these various towers and scrubbers, as noted, are extensively instrumented to obtain meaningful data. An elaborate system of interlocks and emergency power systems are in reserve in case primary power is lost during an incineration run.

This incinerator line is now undergoing final checkout and it is anticipated that actual combustion of TRU materials will begin during April of 1978.

To date, based on the experience gained during the tests with nonradioactive materials, the ash produced is of low density and undoubtedly will require some sort of fixation for transport to a burial or storage area. Since programs involving fixation are now ongoing in various countries, these will be evaluated and one will be selected for fixation of the LASL incinerator ash. In this regard, the LASL Waste Management Group maintains close liaison with other U.S. DOE contractors who are developing criteria for a terminal isolation facility. Therefore, it is planned to incorporate a fixation process which will be compatible with those criteria. Because of the LASL's long familiarity and expertise with basic plutonium chemistry, the recovery of plutonium and other TRU elements from the ash will be examined.

While the precise value remains to be defined by the development and demonstration studies, overall volume reduction factors of 35:1 are anticipated from the controlled-air incineration even including those waste streams produced in the process such as contaminated scrub solutions, etc.

Other developmental studies in progress within the waste management activities at the LASL include a detailed examination of radiolytic reactions resulting from the interaction of the alpha particles of TRU elements and hydrogenous waste matrices representative of those in retrievable storage at several U.S. sites in addition to the LASL. While radiolysis does occur and some carbon-hydrogen-oxygen bonds are broken with the resulting formation of hydrogen gas, the formation rate is so slow, even for maximum allowable loadings of ^{239}Pu in each container, that hydrogen generation is not a problem. In addition to laboratory tests, actual waste-containing drums within the storage pits have been instrumented.

Some of these drums contain considerable amounts of ^{238}Pu. Gas samples periodically withdrawn from these drums confirm the generation of hydrogen but pressurization has never been noted. Therefore, the highly mobile hydrogen diffuses away from its generation point and harmlessly into the atmosphere. No detectable radioactivity has been found outside these drums. As would be expected, various components of a typical hydrogenous waste matrix undergo radiolytic attack at different rates; however, even in the worst case, hydrogen generation rates are not a problem.

Therefore, the LASL Waste Management Group maintains a very flexible position in being able to verify and correlate laboratory data with actual field test results. The combination of continuing liquid and solid waste disposal requirements along with the various Waste Management research, development, and demonstration work provides a very broad base for technical investigation and evaluation. The LASL Waste Management Group is also preparing various Waste Management Plans for the DOE; that is, to evaluate the various technical options now under investigation in the United States and formulate an overall plan to be used by DOE for future waste management decisions.

TABLE I

OPERATING DATA FOR LASL LIQUID WASTE PROCESSING PLANTS

Base Year: 1976

Volume Treated: 44.6×10^{6} liters

AVERAGE CONCENTRATIONS, μCi/mℓ

Nuclide	Influent	Effluent	% Removed
^{238}Pu	6.98×10^{-5}	1.12×10^{-7}	99.8
^{239}Pu	5.03×10^{-5}	3.66×10^{-8}	99.9
^{241}Am	1.47×10^{-5}	2.76×10^{-8}	99.8

TABLE II

SOLID WASTE BURIED/STORED AT LASL IN 1976

	Volume (m^3)	Radioactivity (Ci)
Buried Waste		
TRU-Contaminated (<10nCi/g)	6298.3	980.4
U-Contaminated	2377	2.1
FP/IA-Contaminated	136.9	42.6
Tritium-Contaminated	20.7	37650
TOTAL	8832.9	38675.1
Transuranic (TRU) Waste Stored (>10 nCi/g)	320.2	18216

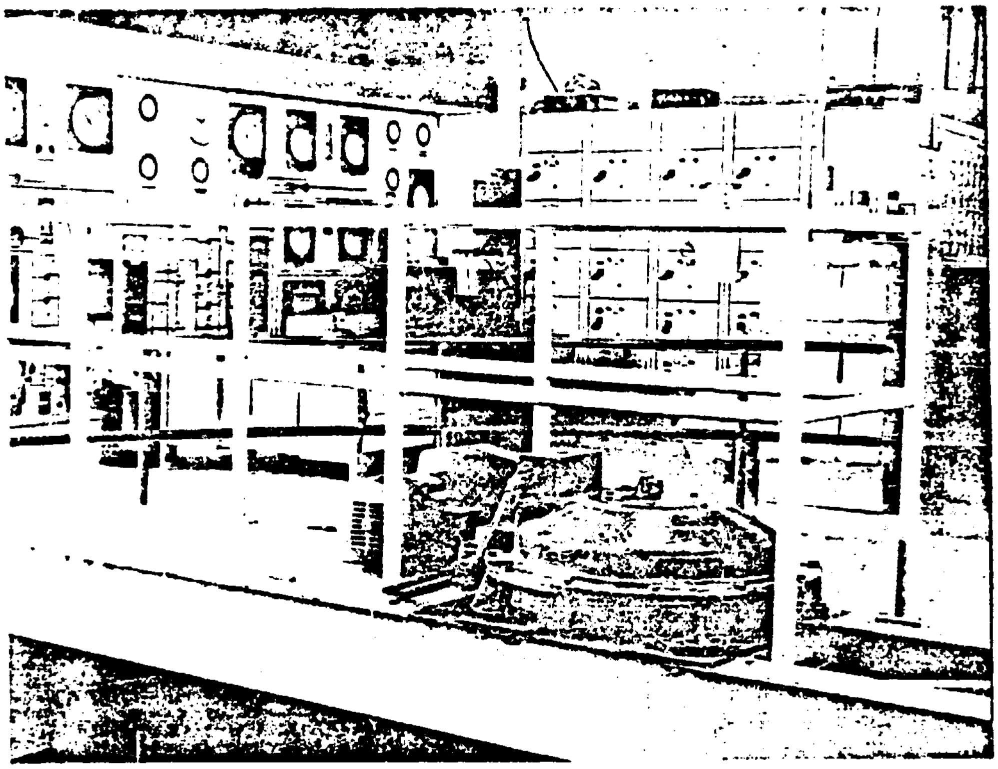

Fig. 1. LASL Liquid Waste Processing Unit

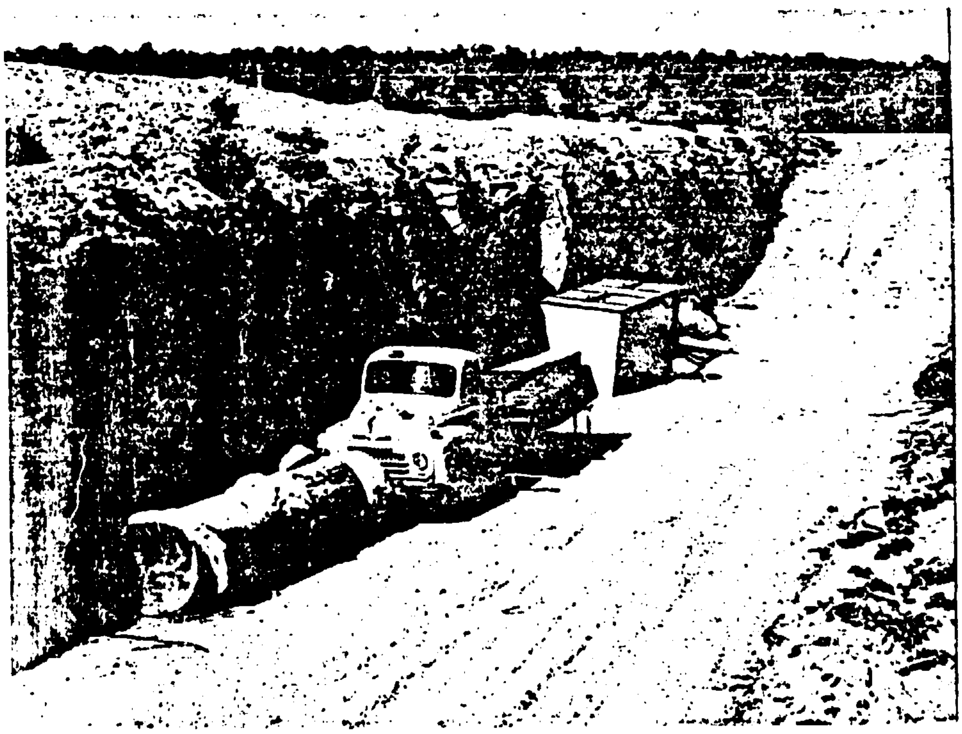

Fig. 2. Burial Items Awaiting Backfilling

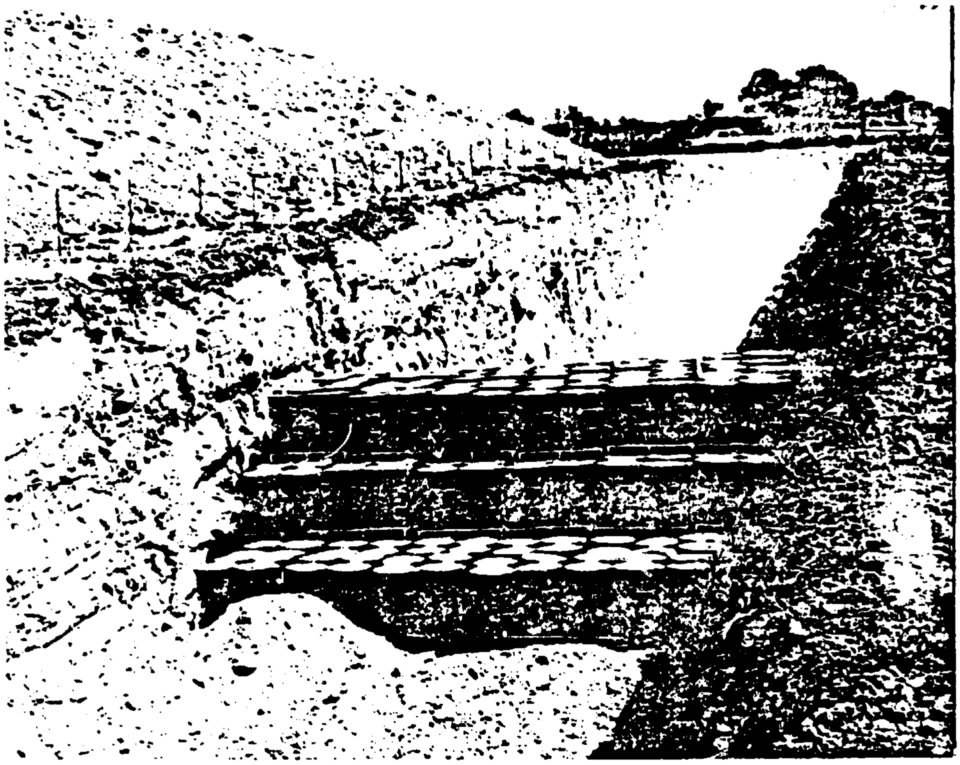

Fig. 3. Barrels of Waste in a LASL Burial Pit

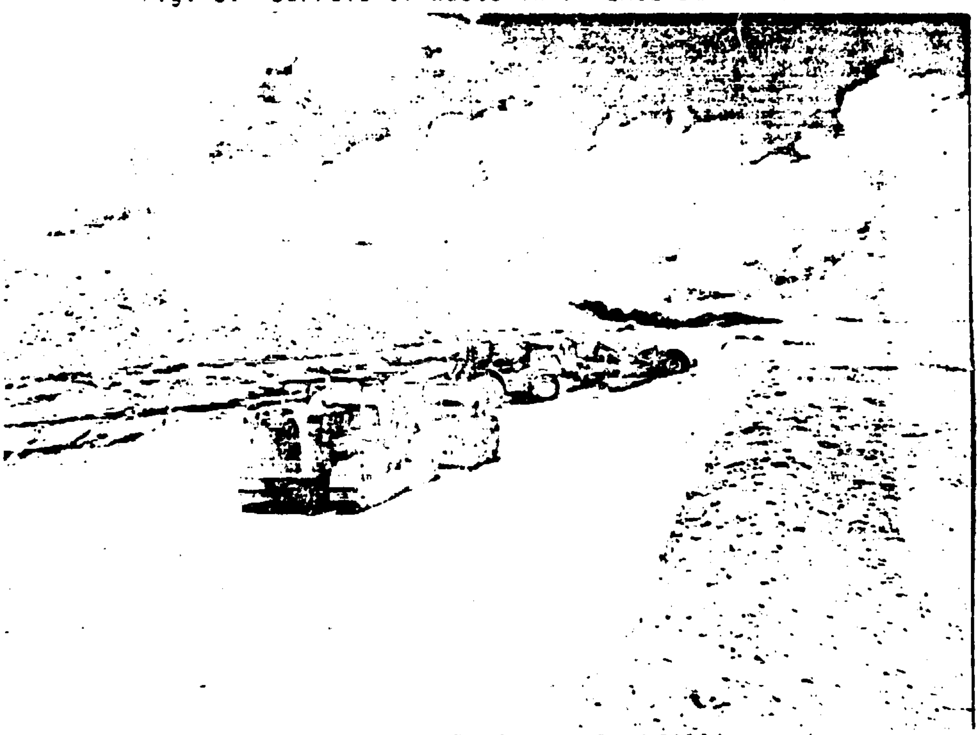

Fig. 4. Earthmoving Equipment Backfilling and Covering a LASL Burial Pit.

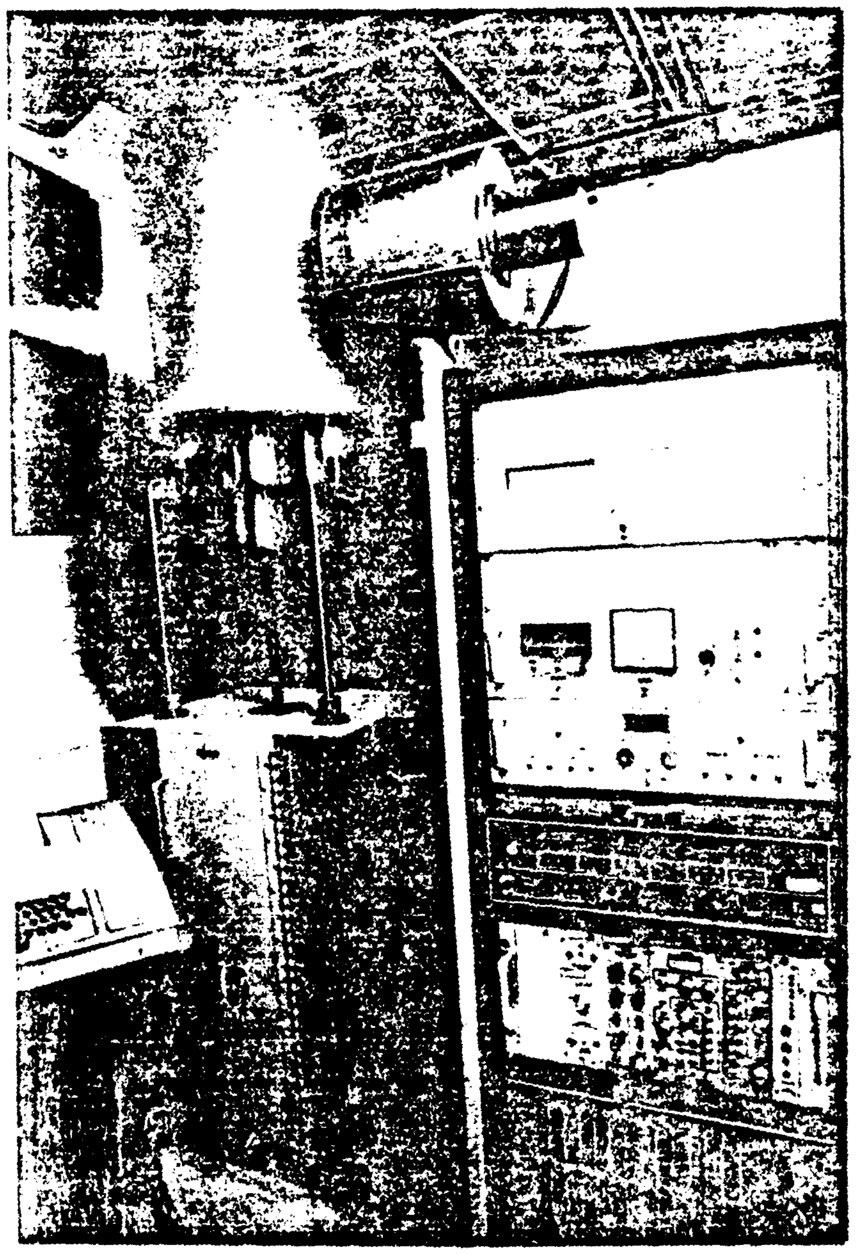

Fig. 5. LASL Multiple Energy Gamma Assay System For Scanning Waste Boxes at 10 nCi/g.

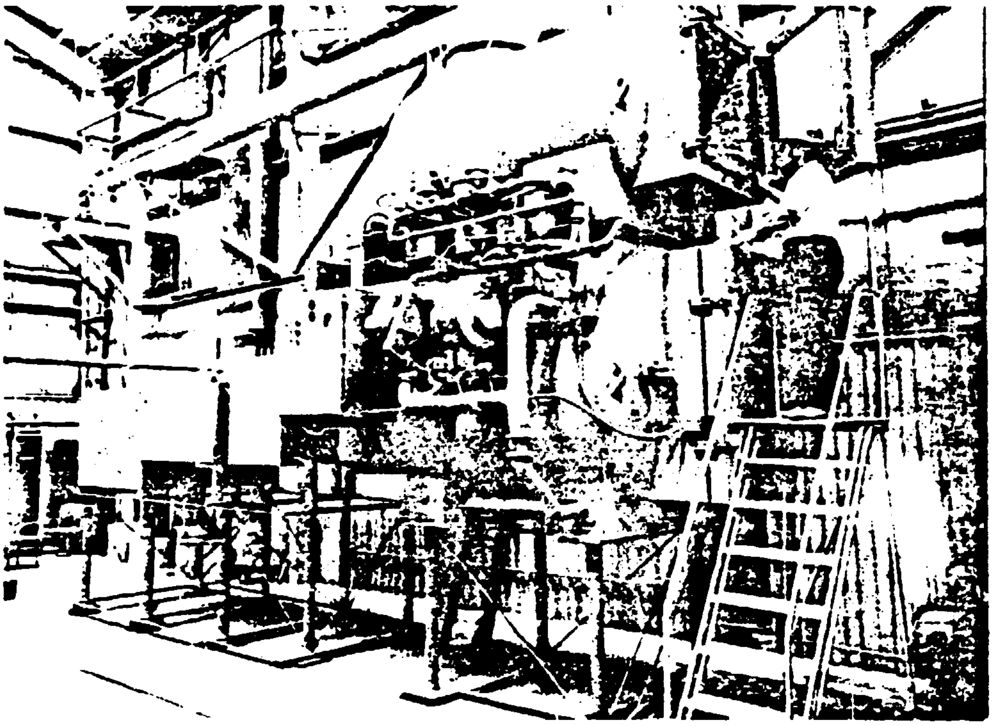

Fig. 6. The LASL Controlled Air Incinerator During Testing with Nonradioactive Waste.

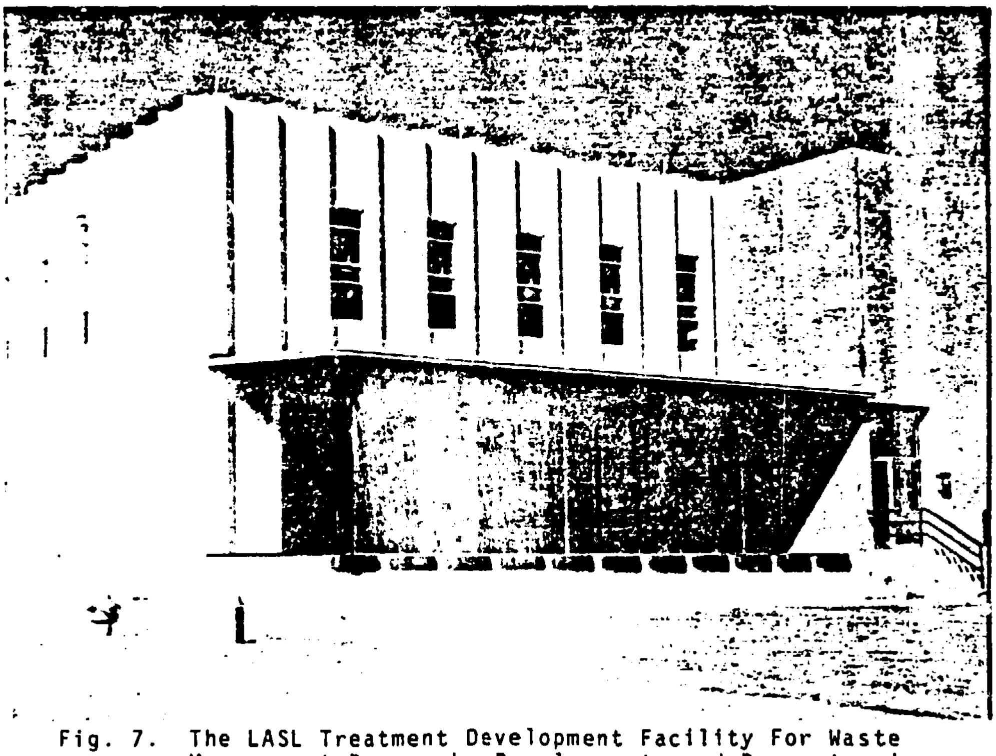

Fig. 7. The LASL Treatment Development Facility For Waste Management Research, Development, and Demonstration.

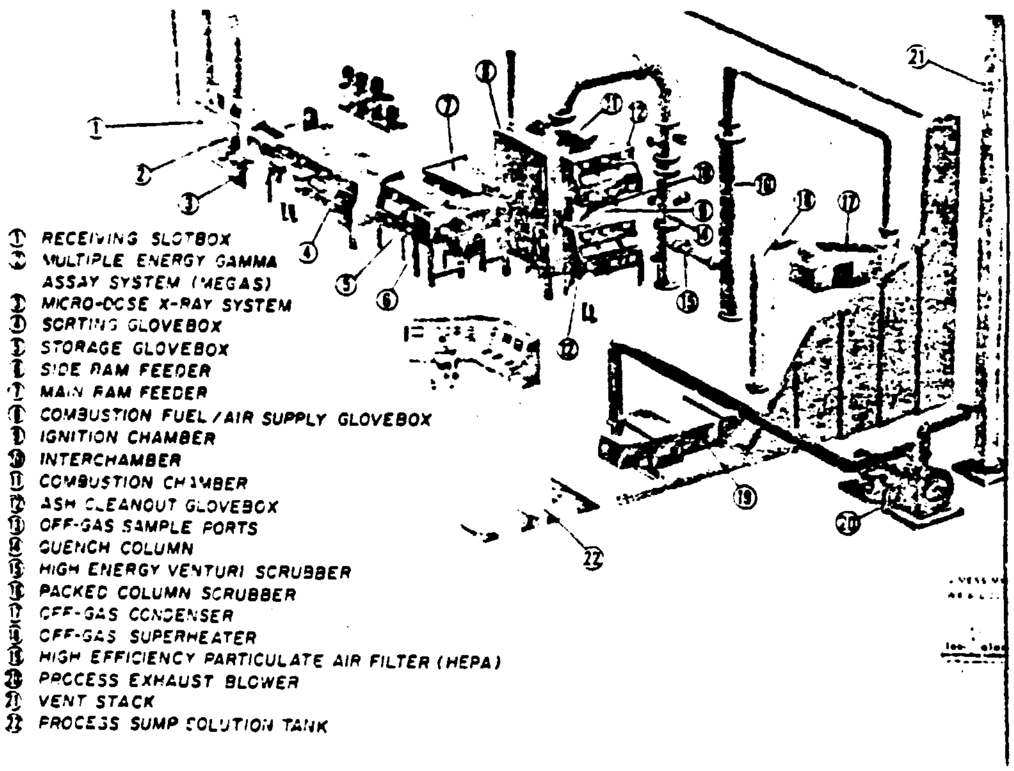

Fig. 8. Schematic Drawing of the LASL Incinerator and Its Glovebox Line and Off-gas Scrubbing System.